Stopping Oscillations of Audio Amplifier Circuits Or Integrated Circuits (ICs)

You might have seen this a few times before. You might have seen a circuit on the internet, or you purchased an audio amplifier IC. However, when you connect it to power supply and speakers you cannot stop oscillations. This article shows a few solutions to the problem.

1. Oscillations from Power Supply Only

1.1 Increase the Current Limit on Your Power Supply

By increasing the current limit on your power supply, you are effectively reducing the source resistance or source impedance and thus reducing the amplitudes of possible power supply oscillations. You might even need to use a higher current power supply if the maximum current limit is low. You can also connect a few batteries in parallel. However, make sure that the voltage of those batteries is very similar. Otherwise they might explode. Also, smaller voltage batteries will drain power from higher voltage batteries. You might need to use a smart power supply or voltage regulator network.

1.2 Power Supply Filtering Capacitor

You might have seen a capacitor placed in parallel with the power supply in IC specifications or website circuits. At times the charging capacity, Farad values of those capacitors are very low, thus might not be high enough to filter the power supply oscillations. Higher capacitors can filter lower frequencies and reduce the amplitude of higher frequencies. However, increasing the capacitor value might cause the failure of power supply or explosion of the capacitor if the power supply source resistance is low. You should always check the maximum:

- Power, voltage and current characteristics of the capacitors (try connecting a few capacitors in parallel),
- Maximum current output of the power supply and short circuit protection characteristics of the power supply, source protection (mains socket) of the power supply (you do not want to blow the fuse).

1.3 Increasing the Load Resistance

When the amplifier drives a high current load, it takes more current from the power supply and this can lead to a oscillations in the power supply voltage rail. You can try replacing a speaker with a headphone or higher impedance speaker. Bigger speakers have lower impedances. This could be as low as 4 ohms. Some head phones can have 100 ohm impedance because less current is needed to drive the head phone speakers because they are smaller.

1.4 Feedback

When I was in university, I was taught that feedback can reduce the EMI or temperature noise from components inside the amplifier. However, in my opinion such application of feedback is not very affective due to unpredicted characteristics of random noise waveforms and time delays of analogue signals from input to output and from output to input. However, feedback could be useful when reducing the amplitude of single frequency power supply oscillations inside amplifier (one spike in the frequency spectrum). Feedback also reduces the amplifier gain and improves biasing stability that can be affected by power supply voltages, temperature changes or components characteristic differences due to manufacturing tolerances.

2 Oscillations from Power Supply, Noise or EMI (Electromagnetic Interference)

2.1 Match the Source impedance or Resistance of Inputs

This is both for power supply and noise issues. Some audio amplifiers have two inputs. If the source impedance is the same, then all oscillations and noises at the input are cancelled when the difference of the inputs are almost eliminated due to subtraction of second channel form the first inside the amplifier, thus significantly reducing the common noise and oscillation signals. However, this depends on the Common Mode Rejection Ratio (CMRR) of the amplifier. The problem with this solution is matching the resistance of the two sources. You can use a few small value resistors (expensive but a reliable method) or a variable resistor (not a reliable solution).

2.2 Reducing the Gain

Some amplifiers have gain control option. Reducing the gain can be done with control resistor of feedback network. This was well practised for many decades in electronics industry. You can connect a potentiometer at the input to reduce the input magnitude. This will reduce the chances of output saturation and improve the output signal quality. You can also try an automatic gain control (AGC) system. Simple and slow response control systems with Schmitt triggers or two comparators (standard IC comparators or operational amplifiers) are the best solution. More complicated control systems are faster but might cause oscillations or even affect the output signal waveforms. Thus, fast control systems are not necessary in my opinion although they could be useful for preventing ear damage if a loud signal is suddenly applied to your amplifier.

2.3 Filtering the Output

This is the worst solution in my opinion. You can try a notch filter that filters one frequency, 50 Hz or 60 Hz mains power supply sinusoidal waveforms. However, usually an oscillation might cause the output signal to saturate or the oscillations might consist of many frequencies. A saturated signal will produce a square wave that consists of a large amount of frequencies and can be modelled by addition of multiple sinusoidal waveforms. A notch filter

will not be able to filter all those frequencies. Some of those waveforms might have different phase delays. Each sinusoid is one frequency. Look up Fourier series. The power supply mains frequency could be 49 Hz or 61 Hz. The notch filter frequency might also vary depending on component tolerances unless you are using a digital notch filter. A more effective solution is to use a high pass filter to eliminate any sinusoids under 100 Hz or a low pass filter. There could high frequency noises that you do not want to hear. Some communication systems have bandwidth of only 3 kHz. Therefore, Skype or phone speech might be harder to understand at times. There are even amplifiers with bandwidth as low as 1 kHz that is very low in my opinion. However, hearing noise is not pleasant either.

2.4 Using Two Amplifiers

You can try connecting a speaker between the outputs of two similar amplifiers. This is also a not very effective solution if both outputs are saturated. However, I seen this method used in old telecommunication circuits.

3 Conclusion

Newer circuits and integrated circuits are more likely to work with no noise and no power supply oscillations. Those are the reasons:

- Using of class D amplifier instead of class B amplifier improves power supply efficiency thus draining less current from power supply and can work with high source impedance or low current power supply sources,
- Better CMRR due improved manufacturing in terms of precision and lower cost,
- Internal automatic gain control (AGC) systems,
- Use of feedback for temperature and power supply changes stability,
- Better frequency filtering, use of digital filtering.

Thus, all those methods presented in the article might not be necessary for those new but probably expensive integrated circuits (ICs). However, ICs have lower current limits than transistors. At high currents, sparks can jump between two surface mount pins or even throw hole IC pins that less likely to happen with power transistors. Therefore, ICs are made to work with lower currents, voltages and power limits. You need consider the maximum power that you need from our audio power amplifier.

Dr Mark Glickman, Melbourne, Victoria, Australia